establish a similar, but not identical, community; to establish an entirely different but valued community; or, if none of the foregoing is feasible, to establish some less-valued community.”

The costs discussed above include costs for environmental restoration.

DIRS 152083-Chanin and Murfin (1996, all) provide the following assessments of environmental restoration that could be accomplished following clean up of contamination from an accident.

- Unassisted restoration of desert land is difficult, but assisted restoration can be very successful.
- Grasslands may be restored naturally provided only limited soil has been removed. Assisted restoration of prairies is also successful.
- Total restoration of forests may not be possible if the area is too large for natural reseeding; an alternative use may have to be found for forestland.
- Restoration of farmland is relatively simple.
- Restoration of urban land to building sites is simple.
- Restoration to parkland is possible, but more costly.

J.2 Evaluation of Rail and Intermodal Transportation

DOE could use several modes of transportation to ship spent nuclear fuel from the 72 commercial and 5 DOE sites. Legal-weight trucks could transport spent nuclear fuel and high-level radioactive waste in truck casks that would weigh approximately 22,500 kilograms (25 tons) when loaded. For sites served by railroads, railcars could be used to ship rail casks directly to the Yucca Mountain site, if a branch rail line was built in Nevada, or to an intermodal transfer station in Nevada if heavy-haul trucks were used. Rail casks would weigh as much as 136,000 kilograms (150 tons).

For sites that have the capability to load rail casks but are not served by a railroad, DOE could use heavy-haul trucks or, for sites on navigable waterways, barges to transport casks to nearby railheads.

For rail shipments, DOE could request the railroads to provide dedicated trains to transport casks from the sites to a destination in Nevada or could deliver railcars with loaded casks to the railroads as general freight for delivery in Nevada.

In addition, DOE evaluated the potential for including two other scenarios: (1) a different mostly rail scenario in which railcars would transport legal-weight truck casks and (2) a large-scale barge scenario.

J.2.1 LEGAL-WEIGHT TRUCK CASKS ON RAILCARS SCENARIO

DOE assessed the sensitivity of transportation impacts to assumptions related to transportation scenarios. The analysis evaluated a variation of the mostly rail scenario in which shipments would be made using casks much smaller than rail casks—legal-weight truck casks—shipped to Nevada on railcars then transported on legal-weight trucks from a rail siding to Yucca Mountain. Under this scenario, because all shipments (except shipments of naval spent nuclear fuel) would use legal-weight truck casks, the number of railcar shipments would be about 53,000 over the 24 years of the Proposed Action. This would be the same as the number of legal-weight truck plus naval spent nuclear fuel shipments in the mostly legal-weight truck scenario.

DOE estimated impacts of this variation of the mostly rail transportation scenario by scaling from the impacts estimated for the mostly rail scenario. The analysis used the ratio of the number of railcars that would be shipped to the number of railcar shipments estimated for the mostly rail scenario and assumed each shipment would include an escort car and five railcars carrying legal-weight truck casks. The estimated number of public incident-free latent cancer fatalities would be approximately 4, and the estimated number of traffic fatalities would be 8. The total of these estimates, 12, is about 1.5 times the DOE revised estimate of a total of 7 fatalities (2.5 latent cancer fatalities plus 4.5 traffic fatalities) for the legal-weight truck scenario.

DOE determined that while this scenario would be feasible, it would not be practical. The number of shipping casks and railcar shipments would be greater by a factor of 5 than for the mostly rail scenario and the additional cost to the Program would be more than $1 billion. In addition, the truck-casks-on-railcars scenario would lead to the highest estimates of occupational health and public health and safety impacts, most coming from rail-traffic related facilities.

J.2.2 LARGE-SCALE BARGE SCENARIO

In response to public comments on the 1986 Environmental Assessment for the Yucca Mountain Site, Research and Development Area, Nevada (DIRS 104731-DOE 1986, p. C.2-40), DOE described barge transportation as a feasible alternative that could play a secondary or supplementary role in the transportation of radioactive wastes to a repository. In the Final Environmental Impact Statement on Management of Commercially Generated Radioactive Waste (DIRS 104832-DOE 1980, Volume A, pp. 4.64 and 4.65), DOE concluded that barge transport is an alternative when both the nuclear powerplant and the encapsulation or storage facility are on navigable waterways. That EIS observed that barge transport suggests high payloads and low tariffs, but cost gains in these two areas could be offset by the longer estimated transit times for barge shipments. The EIS also observed that casks for barge shipment of spent nuclear fuel probably would be similar, if not identical, to those used for rail transport.

The most likely way in which DOE would use barge transportation to make shipments to a repository would be to complete a leg of the trip that also involved two land legs. Even though many generator sites are adjacent to or near navigable waterways, shipping casks cannot be loaded directly onto barges in all cases. It would be necessary to use heavy-haul trucks or railcars to transport the casks from the generator site's cask loading facilities to a barge slip or dock. The casks would then either be rolled onto the barge using the land vehicle and a loading ramp and secured to the barge deck or hoisted from the land vehicle to the barge and secured. At the destination end of the barge leg of the trip, the cask would either be rolled off the barge using a ramp and a heavy-haul truck or hoisted from the barge deck onto a railcar or heavy-haul truck. The cask probably would then be transported from the destination port to Nevada by rail and not by heavy-haul truck. Thus, if casks were rolled off barges to heavy-haul trucks, they would need to be transferred to railcars. The maximum use of barge transportation would require transport through the Panama Canal for shipments from generator sites in the middle and eastern part of the United States. Such use could result in 70 percent fewer land travel kilometers than the mostly rail or mostly legal-weight truck scenario.

Analyses in the 1986 Environmental Assessment (DIRS 104731-DOE 1986, p. A-69) showed that the use of barge transportation would generally increase occupational exposure for normal shipment operations and could increase exposure of the public because of intermodal transfers. From the analyses, reactor-specific results suggest that under several circumstances the barge mode could reduce risk. The analyses concluded that the consequences of accidents from barges would be of the same magnitude as those for other modes.

Because, as discussed above, DOE could use barge transportation only in conjunction with land modes, DOE did not evaluate barge as an alternative major modal scenario as it did for the mostly rail and mostly legal-weight truck modal scenarios. Rather, for the 17 commercial generator sites not served by railroads but situated near or adjacent to navigable waterways, DOE evaluated and compared the potential use of barges and heavy-haul trucks to transport casks containing spent nuclear fuel from these sites to nearby railheads. The analysis assumed barges or heavy-haul trucks would be offloaded at the railheads and the casks would be transferred to railcars for shipment to Nevada.

DOE eliminated the large-scale barge scenario from further consideration in the EIS because it would be overly complex, requiring greater logistical complexity than either rail or legal-weight truck transportation; a much greater number of large rail casks than rail transport; much greater cost than either rail or legal-weight truck transportation; long transport distances potentially requiring the transit of the Panama Canal outside U.S. territorial waters; transport on intercoastal and coastal waterways of coastal states and on major rivers through and bordering states; extended transportation times; intermodal transfer operations at ports; and land transport from a western port to Yucca Mountain. If in the future DOE concluded that barge transportation was reasonable and proposed to make use of it, the Department would conduct additional National Environmental Policy Act evaluations to assess potential impacts of the greater use.

J.2.3 EFFECTS OF USING DEDICATED TRAINS OR GENERAL FREIGHT SERVICE

The Association of American Railroads recommends that only special (dedicated) trains move spent nuclear fuel and certain other forms of radioactive materials (DIRS 103718-DOT 1998, p. 2-6). In developing its recommendation, the Association concluded that the use of special trains would provide operational (for railroads and shippers) and safety advantages over shipments that used general freight service. Notwithstanding this recommendation, the U.S. Department of Transportation study (DIRS 103718-DOT 1998, all) compared dedicated and regular freight service using factors that measure impacts to overall public safety. The results of this study indicated that dedicated trains could provide advantages over regular trains for incident-free transportation but could be less advantageous for accident risks. However, available information does not indicate a clear advantage for the use of either dedicated trains or general freight service. Thus, DOE has not determined the commercial arrangements it would request from railroads for shipment of spent nuclear fuel and high-level radioactive waste. Table J-25 compares the dedicated and general freight modes. These comparisons are based on the findings of the U.S. Department of Transportation study and the Association of American Railroads.

J.2.4 IMPACTS OF THE SHIPMENT OF COMMERCIAL SPENT NUCLEAR FUEL BY BARGE AND HEAVY-HAUL TRUCK FROM 24 SITES NOT SERVED BY A RAILROAD

The mostly rail scenario includes 24 sites that do not have direct rail access. For those sites, heavy-haul trucks would be used to haul the spent nuclear fuel casks to the nearest railhead. As shown in Figure J-9 (a multipage figure), 17 of the 24 sites are on navigable waterways, so barge transport could be a feasible way to move spent nuclear fuel to the closest railhead with barge access. This section estimates the changes in impacts to the mostly rail scenario if barge transport replaced heavy-haul truck transport for these 17 sites.

J.2.4.1 Routes for Barges and Heavy-Haul Trucks

The distances from the 24 sites to railheads range from about 6 to 75 kilometers (4 to 47 miles). DOE used the HIGHWAY computer code to estimate routing for heavy-haul trucks (DIRS 104780-Johnson et al. 1993, all). The INTERLINE computer code (DIRS 104781-Johnson et al. 1993, all) was used to generate route-specific distances that would be traveled by barges. Table J-26 lists estimates for route lengths for barges and heavy-haul trucks. Table J-27 lists the number of shipments from each site.

Table J-25. Comparison of general freight and dedicated train service.

Attribute	General freight	Dedicated train
Overall accident rate for accidents that could damage shipping casks	Same as mainline railroad accident rates	Expected to be lower than general freight service because of operating restrictions and use of the most up-to-date railroad technology.
Grade crossing, trespasser, worker fatalities	Same as mainline railroad rates for fatalities	Uncertain. Greater number of trains could result in more fatalities in grade crossing accidents. Fewer stops in classification yards could reduce work related fatalities and trespasser fatalities.
Security	Security provided by escorts required by NRC[a] regulations	Security provided by escorts required by NRC regulations; fewer stops in classification yards than general freight service.
Incident-free dose to public	Low, but more stops in classification yards than dedicated trains. However, classification yards would tend to be remote from populated areas.	Lower than general freight service. Dedicated trains could be direct routed with fewer stops in classification yards for crew and equipment changes.
Radiological risks from accidents	Low, but greater than dedicated trains	Lower than general freight service because operating restrictions and equipment could contribute to lower accident rates and reduced likelihood of maximum severity accidents.
Occupational dose	Duration of travel influences dose to escorts	Shorter travel time would result in lower occupational dose to escorts.
Utilization of resources	Long cross-country transit times could result in least efficient use of expensive transportation cask resources; best use of railroad resources; least reliable delivery scheduling; most difficult to coordinate state notifications.	Direct through travel with on-time deliveries would result in most efficient use of cask resources; least efficient use of railroad resources. Railroad resource demands from other shippers could lead to schedule and throughput conflicts. Easiest to coordinate notification of state officials.

a. NRC = U.S. Nuclear Regulatory Commission.

J.2.4.2 Analysis of Incident-Free Impacts for Barge and Heavy-Haul Truck Transportation

J.2.4.2.1 *Radiological Impacts of Incident-Free Transportation*

This section compares radiological and nonradiological impacts to populations, workers, and maximally exposed individuals for the mostly rail case when casks from heavy-haul truck transport would be switched to barge for 17 of the 24 heavy haul truck sites. To make the comparison, the analysis retained any assumptions not affected by the mode change for the 17 sites. Thus:

- The seven sites that would ship by heavy-haul truck and do not have barge access would ship by heavy-haul truck in the barge case.
- The sites that would ship by legal-weight truck in the mostly rail case still ship by legal-weight truck for the barge analysis.
- For the rail segments of the routes that would use barge transport, separate INTERLINE runs determined the routes from the closest barge dock with rail access to each of the six end nodes in Nevada. While these routes are normally the same outside the origin state, no restrictions were imposed on INTERLINE requiring that the routes outside the origin state be the same.

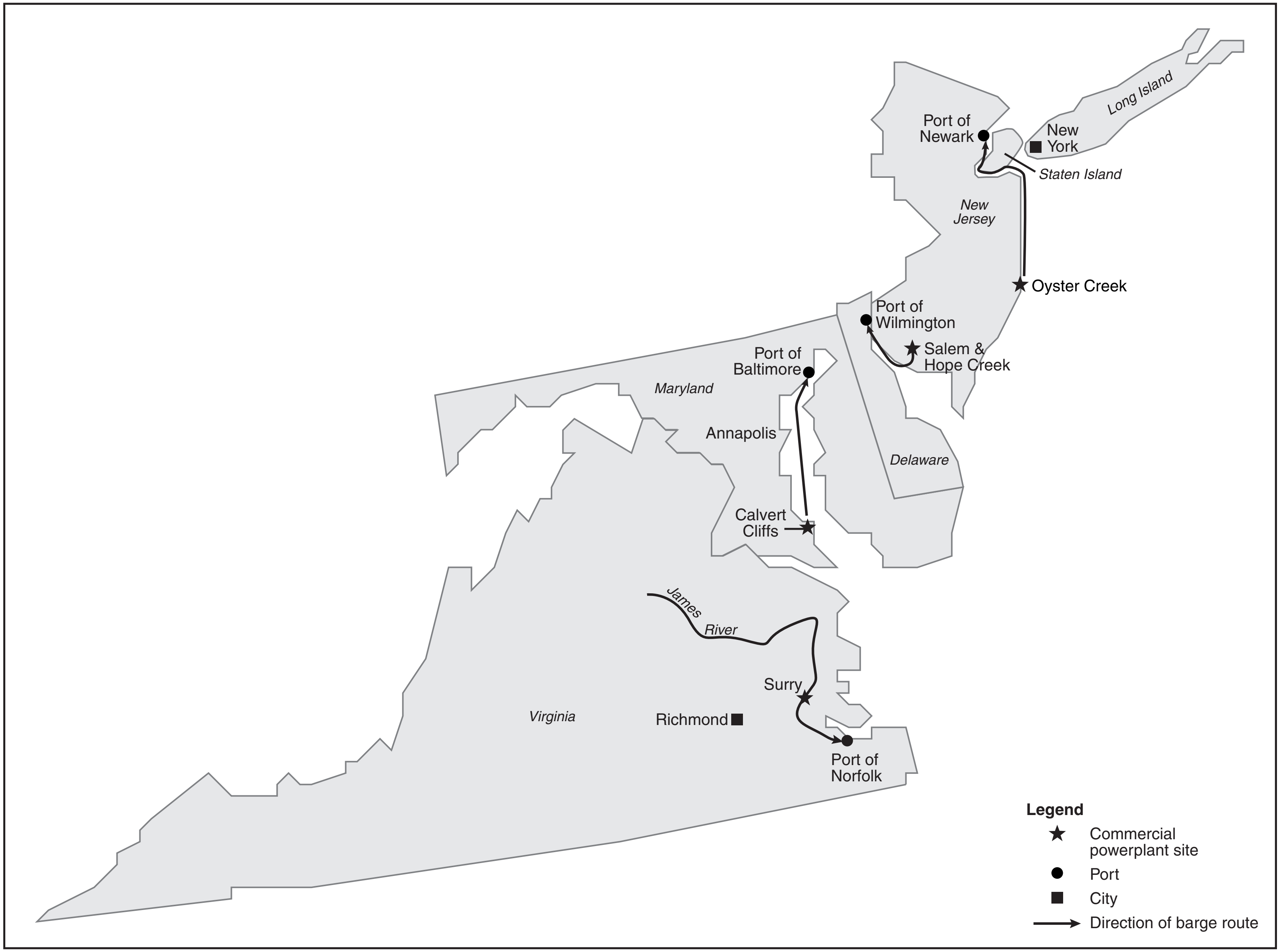

Figure J-9. Routes analyzed for barge transportation from sites to nearby railheads (page 1 of 4).

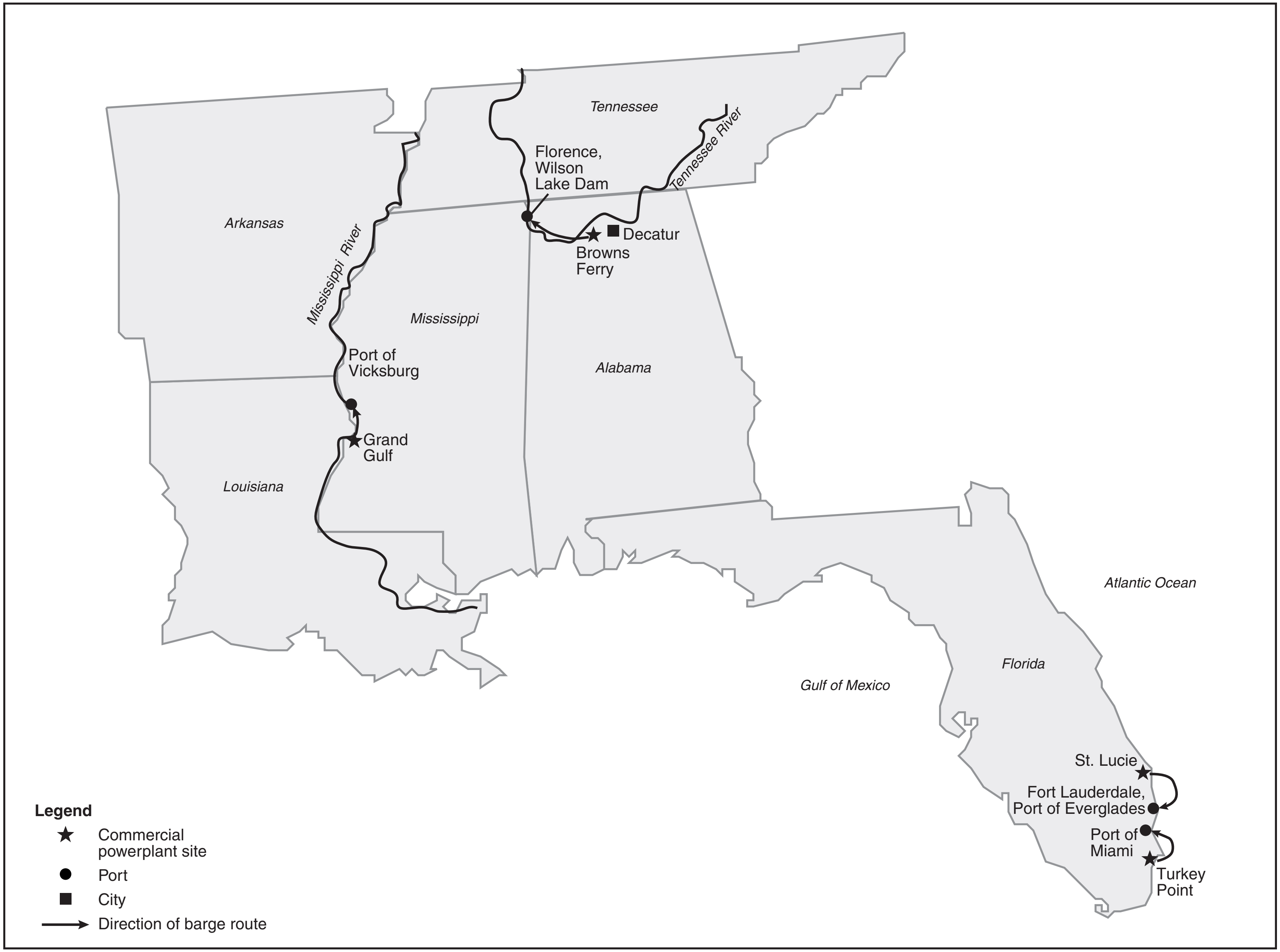

Figure J-9. Routes analyzed for barge transportation from sites to nearby railheads (page 2 of 4).

Figure J-9. Routes analyzed for barge transportation from sites to nearby railheads (page 3 of 4).

Figure J-9. Routes analyzed for barge transportation from sites to nearby railheads (page 4 of 4).

Table J-26. National transportation distances from commercial sites to Nevada ending rail nodes (kilometers).[a,b]

Site (intermodal rail node)[c]	Rail transportation Total[d]	Rail Rural	Rail Suburban	Rail Urban	Barge transportation Total[d]	Barge Rural	Barge Suburban	Barge Urban
Browns Ferry NP[e]	3,279 - 3,656	2,985 - 3,306	260 - 300	34 - 49	57	51	5	0
Calvert Cliffs NP	4,028 - 4,404	3,270 - 3,592	610 - 650	148 - 162	99	98	2	0
Cooper NP	2,029 - 2,405	1,910 - 2,231	98 - 138	21 - 36	117	100	16	1
Diablo Canyon NP	582 - 1,453	375 - 1,006	112 - 311	94 - 136	143	143	0	0
Grand Gulf NP	3,298 - 3,665	2,859 - 3,333	270 - 373	28 - 67	51	51	0	0
Haddam Neck NP	4,339 - 4,716	3,316 - 3,637	842 - 882	182 - 197	99	89	10	0
Hope Creek NP	4,229 - 4,605	3,458 - 3,779	655 - 695	116 - 131	30	30	0	0
Indian Point NP	4,351 - 4,727	3,425 - 3,746	766 - 806	160 - 175	68	13	39	15
Kewaunee NP	2,864 - 3,241	2,506 - 2,827	291 - 331	68 - 82	177	171	1	5
Oyster Creek NP	4,337 - 4,714	3,420 - 3,741	765 - 806	152 - 167	130	77	36	17
Palisades NP	3,060 - 3,436	2,607 - 2,929	355 - 395	97 - 112	256	256	0	0
Pilgrim NP	4,393 - 4,769	3,338 - 3,659	858 - 899	196 - 211	74	41	33	0
Point Beach NP	2,864 - 3,241	2,506 - 2,827	291 - 331	68 - 82	169	163	1	5
Salem NP	4,229 - 4,605	3,458 - 3,779	655 - 695	116 - 131	34	34	0	0
St. Lucie NP	4,840 - 5,136	3,934 - 4,205	756 - 842	87 - 139	140	50	52	38
Surry NP	4,403 - 4,780	3,773 - 4,094	554 - 595	76 - 90	71	60	8	3
Turkey Point NP	4,882 - 5,178	3,937 - 4,208	765 - 851	117 - 169	54	53	0	1
Big Rock Point NP HH – 20.0 kilometers	3,258 - 3,595	2,766 - 3,059	399 - 431	93 - 105	--[f]	--	--	--
Callaway NP HH – 18.5 kilometers	2,491 - 2,868	2,352 - 2,674	119 - 159	20 - 35	--	--	--	--
Fort Calhoun NP HH – 6.0 kilometers	1,997 - 2,373	1,905 - 2,227	81 - 122	10 - 25	--	--	--	--
Ginna NP HH – 35.1 kilometers	3,532 - 3,869	2,792 - 3,086	604 - 636	136 - 147	--	--	--	--
Oconee NP HH – 17.5 kilometers	3,999 - 4,375	3,470 - 3,792	475 - 515	54 - 68	--	--	--	--
Peach Bottom NP HH – 58.9 kilometers	4,110 - 4,486	3,383 - 3,704	616 - 656	111 - 126	--	--	--	--
Yankee Rowe NP HH – 10.1 kilometers	3,998 - 4,335	3,083 - 3,376	752 - 784	164 - 175	--	--	--	--

a. To convert kilometers to miles, multiply by 0.62137.
b. Distances estimated using INTERLINE computer program. Salem/Hope Creek treated as two sites.
c. Intermodal rail nodes selected for purpose of analysis. Source: (DIRS 104800-CRWMS M&O 1999, all).
d. Totals might differ from sums of rural, suburban, and urban distances due to method of calculation and rounding.
e. NP = nuclear plant.
f. -- = sites not located on a navigable waterway.

The analysis included radiological impacts of intermodal transfers at the interchange from heavy-haul trucks to railcars or barges to railcars. Workers would be exposed to radiation from casks during transfer operations. However, because the transfers would occur in terminals and berths remote from public access, public exposures would be small. Impacts of constructing intermodal transfer facilities were not included because intermodal transfers were assumed to take place at existing facilities.

The analysis assumed that heavy-haul trucks would travel at a lower speed than legal-weight trucks and that barge transport would be even slower. The assumed speed was 40 kilometers (25 miles) per hour and 8 kilometers (5 miles) per hour for heavy-haul truck and barge transport, respectively. These speeds were assumed to be independent of any population zone. Because travel distances to nearby railheads are short in relation to the distances traveled by rail, the expected impacts of heavy-haul truck and barge transportation would be much smaller than those of national rail shipments. The analysis of impacts for barge shipments assumed that the transport would employ commercial vessels operated by maritime

Table J-27. Barge shipments and ports.

Plant name	State	Number of shipments			Barge ports assumed for barge-to-rail intermodal transfer
		Proposed Action	Module 1	Module 2	
Browns Ferry 1	AL	122	247	248	Wilson Loading Dock
Browns Ferry 2	AL	0	0	1	Wilson Loading Dock
Browns Ferry 3	AL	51	120	121	Wilson Loading Dock
Diablo Canyon 1	CA	60	148	150	Port Huememe
Diablo Canyon 2	CA	61	160	162	Port Huememe
Haddam Neck	CT	40	40	42	Port of New Haven
St. Lucie 1	FL	12	13	16	Port Everglades
St. Lucie 2	FL	61	147	150	Port Everglades
Turkey Point 3	FL	52	85	87	Port of Miami
Turkey Point 4	FL	52	86	88	Port of Miami
Calvert Cliffs 1	MD	169	320	323	Port of Baltimore
Calvert Cliffs 2	MD	0	0	3	Port of Baltimore
Pilgrim	MA	24	18	19	Port of Boston
Palisades	MI	70	122	125	Port of Muskegon
Grand Gulf 1	MS	80	215	216	Port of Vicksburg
Cooper Station	NE	42	124	125	Port of Omaha
Hope Creek	NJ	67	105	106	Port of Wilmington
Oyster Creek 1	NJ	64	110	111	Port of Newark
Salem 1	NJ	59	101	103	Port of Wilmington
Salem 2	NJ	54	108	110	Port of Wilmington
Indian Point 1	NY	0	0	1	Port of Jersey City
Indian Point 2	NY	35	34	36	Port of Jersey City
Indian Point 3	NY	22	19	21	Port of Jersey City
Surry 1	VA	197	330	332	Port of Norfolk
Surry 2	VA	0	0	2	Port of Norfolk
Kewaunee	WI	64	110	111	Port of Milwaukee
Point Beach 1	WI	130	213	215	Port of Milwaukee
Point Beach 2	WI	0	0	2	Port of Milwaukee
Totals		***1,575***	***2,952***	***3,004***	

carriers on navigable waterways and that these shipments would follow direct routing from the sites to nearby railheads. For both modes, intermodal transfers would be necessary to transfer the casks to railcars.

The analysis estimated radiological impacts during transport for workers and the general population. For heavy-haul truck shipments, workers included vehicle drivers and escorts. For barge shipments, workers included five crew members on board during travel. In both the heavy-haul truck and barge cases, the workers would be far enough from the cask such that the major exposure would occur during periodic walkaround inspections. In both cases, consistent with the as-low-as-reasonably-achievable requirement guiding worker exposure, the analysis assumed that only one individual would perform these inspections. The general population for truck shipments included persons within 800 meters (about 2,600 feet) of the road (offlink), persons sharing the road (onlink), and persons at stops. The general population for barging included persons within a range of 200 to 1,000 meters (about 660 to 3,300 feet) of the route. Consistent with normal barge operations, the periodic walkaround inspections would occur while the barge was in motion and there was sufficient crew on board to eliminate the need for intermediate rest stops. Consistent with the RADTRAN 5 modeling, onlink exposures to members of the public during barging were assumed to be negligible. Incident-free unit risk factors were developed to calculate occupational and general population collective doses. Table J-28 lists the unit risk factors for heavy-haul truck and barge shipments. These factors reflect the effects of slower operating speeds for those vehicles in comparison to those for legal-weight trucks.

Table J-29 lists the incident-free impacts using the three shipment scenarios listed above. Impacts of intermodal transfers are included in the results. Occupational impacts would include the estimated radiological exposures of security escorts.

Table J-28. Risk factors for incident-free heavy-haul truck and barge transportation of spent nuclear fuel and high-level radioactive waste.

Mode	Exposure group	Incident-free risk factors (person-rem per kilometer)[a]		
		Rural	Suburban	Urban
Heavy-haul truck	*Occupational*			
	Onlink[b]	5.54×10^{-6}	5.54×10^{-6}	5.54×10^{-6}
	Stops[b]	1.45×10^{-5}	1.45×10^{-5}	1.45×10^{-5}
	General population			
	Offlink[c]	6.24×10^{-8}	6.24×10^{-8}	6.24×10^{-8}
	Onlink[b]	1.01×10^{-4}	7.94×10^{-5}	2.85×10^{-4}
	Stops[b]	3.96×10^{-9}	3.96×10^{-9}	3.96×10^{-9}
	Overnight stop	2.62×10^{-3}		
Barge	*Occupational*[d]	2.11×10^{-6}	2.11×10^{-6}	2.11×10^{-6}
	General population			
	Offlink[c]	1.72×10^{-7}	1.72×10^{-7}	1.72×10^{-7}
	Onlink[b]	0.0	0.0	0.0
	Stops	0.0	0.0	0.0

a. The unit dose factors are developed from the equations in DIRS 155430-Neuhauser, Kanipe, and Weiner (2000, all) in the same way as the unit dose factors in Section J.1.3.
b. Onlink and stopped risk factors consider the exposure to the general population sharing the road and the crew transporting the cask. These factors must be multiplied by the number of shipments and the distance in kilometers in the zone for each segment of the route. The onlink vehicle density for rural transportation in Nevada was estimated using the annual average daily traffic on I-15 at the California-Nevada border (DIRS 103405-NDOT 1997, p. 4).
c. Offlink general population included persons from 30 to 800 meters (about 100 to 2,600 feet) of the road or railway and from 200 and 1,000 meters (about 650 and 3,300 feet) for barge. This risk factor must be multiplied by the number of shipments, distance in kilometers in the zone, and the population density (individuals per square kilometer) in the zone for each segment of the route.
d. Because heavy-haul vehicles cannot be in transit in Nevada for more than 12 hours, an overnight stop is modeled for routes that would require trips longer than 12 hours. This stop is not modeled for the short distances between reactor sites and railheads for indirect rail sites. When used, the factor is multiplied by the number of shipments.

Table J-29. Comparison of population doses and impacts from incident-free national transportation mostly rail heavy-haul truck scenario, mostly rail barge scenario, and mostly truck scenario.[a,b]

Category	Mostly rail (heavy-haul truck)[c]	Mostly rail (barge from 17 of 24 heavy-haul sites)[c]	Mostly truck
Involved worker			
Collective dose (person-rem)	4,300	4,400	14,100
Estimated LCFs[d]	1.7	1.7	5.6
Public			
Collective dose (person-rem)	1,500	1,400	5,000
Estimated LCFs	0.8	0.7	2.5
Maximally exposed individual			
Dose (rem)	0.29	0.29	3.2
Estimated emissions fatalities	0.0001[e]	0.0001[e]	0.0016[f]

a. Impacts are totals for all shipments over 24 years.
b. Includes impacts from intermodal transfer station (see Section 6.3.3.1).
c. Nevada impacts for the mostly rail routes have been averaged to show the effects of using barges at the origin.
d. LCF = latent cancer fatality.
e. Resident near a rail stop.
f. Person at a service station.

As indicated in Table J-29, the differences between the two mostly rail scenarios, heavy-haul truck and barge to nearby railheads, would be much smaller than the differences between the mostly rail scenarios and the mostly truck scenario. Considering only the mostly rail case options, heavy-haul and barge, the slower speed of the barge would tend to make barge exposures higher and the closest distance to resident population, 30 meters (100 feet) versus 200 meters (660 feet) for heavy-haul and barge, respectively, would tend to make barge exposures lower. Differences in the total exposed population or travel distances between the heavy-haul truck and barge routes could result in differences in the collective dose. Table J-29 indicates that the collective dose to the general public would be about the same as the barge case. Because workers would be well away from the cask during transport, the collective dose to workers would depend totally on the number of inspections performed during transit. Table J-29 indicates that these differences would be small. Based on this table, the barge scenario would have approximately the same impacts as the heavy-haul truck scenario that DOE used as a basis for the mostly rail results in Section J.1.3 and J.1.4.

J.2.4.2.2 *Nonradiological Impacts of Incident-Free Transportation (Vehicle Emissions)*

Table J-30 compares the estimated number of fatalities from vehicle emissions from shipments, assuming the use of heavy-haul trucks or barges to ship to nearby railheads.

Table J-30. Estimated population health impacts from vehicle emissions during incident-free national transportation for mostly rail heavy-haul truck and barge scenarios and the mostly legal-weight truck scenario.[a]

Category	Mostly rail (heavy-haul from 24 sites)	Mostly rail (heavy-haul truck from 7 sites and barge from 17)	Mostly truck
Estimated fatalities	0.63	0.62	0.93

a. Impacts are totals over 24 years, including impacts from an intermodal transfer station (see Chapter 6, Section 6.3.3.1).

J.2.4.3 Analysis of Impacts of Accidents for Barge and Heavy-Haul Truck Transportation

J.2.4.3.1 *Radiological Impacts of Accidents*

The analysis of risks from accidents during heavy-haul truck, rail, and legal-weight truck transport of spent nuclear fuel and high-level radioactive waste used the RADTRAN 5 computer code (DIRS 150898-Neuhauser and Kanipe 2000, all; DIRS 155430-Neuhauser, Kanipe, and Weiner 2000, all) in conjunction with an Access database and the analysis approach discussed in Section J.1.4.2. The analysis of risks due to barging used the same methodology with the exception of conditional probabilities. For barge shipments, the conditional accident probabilities and release fractions (Table J-31) for each cask response category were based on a review of other barge accident analyses.

The definitions of the accident severities listed in Table J-31 are based on the analyses reported in DIRS 152476-Sprung et al. (2000, pp. 7-75 to 7-76). DOE used the same accident severity category definitions as those used in the rail analysis described in Section J.1.4.2. If radioactive material was shipped by barge, both water and land contamination would be possible. DIRS 104784-Ostmeyer (1986, all) analyzed the potential importance of water pathway contamination for a spent nuclear fuel transportation accident risk using a “worst-case” water contamination scenario. The analysis showed that the impacts of the water contamination scenario would be about one-fiftieth of the impacts of a comparable accident on land. Therefore, the analysis assumed that deposition would occur over land, not water. DOE used population distributions developed from 1990 Census data to calculate route-specific collective doses. Table J-32 lists the total accident risk for mostly rail case heavy-haul truck scenario, the mostly rail case barge scenario, and the mostly truck scenario. Additional information is in Volume IV.

J.2.4.3.2 *Nonradiological Accident Risks*

As listed in Table J-32, the estimated total fatalities for the mostly rail heavy-haul truck scenario, the mostly rail barge scenario, and the mostly truck scenario would be 2.7, 2.7, and 4.5, respectively. There is essentially no difference between the two mostly rail scenarios. The only significant differences are between those scenarios, and the mostly truck case.

Table J-31. Release fractions and conditional probabilities for spent nuclear fuel transported by barge.

Severity category	Case	Conditional probability	Release fractions (pressurized-water reactor/boiling-water reactor)				
			Krypton	Cesium	Ruthenium	Particulates	Crud
1	21	0.994427	0.0	0.0	0.0	0.0	0.0
2	1, 4, 5, 7, 8	5.00×10^{-3}	$1.96 \times 10^{-1}/2.35 \times 10^{-2}$	$5.87 \times 10^{-9}/7.04 \times 10^{-10}$	$1.34 \times 10^{-7}/1.47 \times 10^{-8}$	$1.34 \times 10^{-7}/1.47 \times 10^{-8}$	$1.37 \times 10^{-3}/5.59 \times 10^{-4}$
3	20	5.00×10^{-6}	$8.39 \times 10^{-1}/8.39 \times 10^{-1}$	$1.68 \times 10^{-5}/1.68 \times 10^{-5}$	$2.52 \times 10^{-7}/2.52 \times 10^{-7}$	$2.52 \times 10^{-7}/2.52 \times 10^{-7}$	$9.44 \times 10^{-3}/9.44 \times 10^{-2}$
4	2, 3, 10	5.00×10^{-4}	$8.00 \times 10^{-1}/8.00 \times 10^{-1}$	$8.71 \times 10^{-6}/8.71 \times 10^{-6}$	$1.32 \times 10^{-5}/1.32 \times 10^{-5}$	$1.32 \times 10^{-5}/1.32 \times 10^{-5}$	$4.42 \times 10^{-3}/4.42 \times 10^{-2}$
5	6	0.0	$8.35 \times 10^{-1}/8.37 \times 10^{-1}$	$3.60 \times 10^{-5}/4.12 \times 10^{-5}$	$1.37 \times 10^{-5}/1.82 \times 10^{-5}$	$1.37 \times 10^{-5}/1.82 \times 10^{-5}$	$5.36 \times 10^{-3}/5.43 \times 10^{-3}$
6	9,11,12,13,14,1 5,16, 17,18,19	1.30×10^{-6}	$8.47 \times 10^{-1}/8.45 \times 10^{-1}$	$5.71 \times 10^{-5}/7.30 \times 10^{-5}$	$4.63 \times 10^{-5}/5.94 \times 10^{-5}$	$1.43 \times 10^{-5}/1.96 \times 10^{-5}$	$1.59 \times 10^{-2}/1.60 \times 10^{-2}$

Table J-32. Comparison of accident risks for the mostly rail heavy-haul truck and barge shipping scenarios.[a]

Category	Mostly rail (heavy-haul option–24 sites)	Mostly rail (barge option–17 of 24 heavy-haul sites)	Mostly truck
Population dose (person-rem)	0.89	1.5	0.5
Estimated LCFs[b]	0.00045	0.001	0.0002
Traffic fatalities[c]	2.7	2.7	4.5

a. Impacts are totals over 24 years.
b. LCF = latent cancer fatality.
c. Traffic fatality impacts for mostly rail scenarios are the average of the range of estimated traffic fatality impacts (2.3 to 3.1) for national transportation for the Proposed Action.

J.2.4.3.3 *Maximum Reasonably Foreseeable Accidents*

From a consequence standpoint, because DOE used the same accident severity bins for rail, heavy-haul truck, and barge transport, the consequences of a release would be the same if the accident occurred in a zone having the same population density. The population densities for barge and heavy-haul truck transport are similar to those for rail. Because the total shipping distance traveled by barge or heavy-haul truck would be a small fraction of the total distance traveled, the maximum reasonably foreseeable accident would be a rail accident. Only minor barge or heavy-haul truck transport accidents would meet the 1×10^{-7} criterion used to identify reasonably foreseeable accidents.

J.3 Nevada Transportation

With the exceptions of the possible construction of a branch rail line or upgrade of highways for use by heavy-haul trucks and the construction of an intermodal transfer station, the characteristics of the transportation of spent nuclear fuel and high-level radioactive waste in Nevada would be similar to those for transportation in other states across the nation. Unless the State of Nevada designated alternative or additional preferred routes as prescribed under regulations of the U.S. Department of Transportation (49 CFR 397.103), Interstate System Highways (I-15) would be the preferred routes used by legal-weight trucks carrying spent nuclear fuel and high-level radioactive waste. Unless alternative or non-Interstate System routes have been designated by states, Interstate System highways would also be the preferred routes used by legal-weight trucks in other states during transit to Nevada.

In Nevada as in other states, rail shipments would, for the most part, be transported on mainline tracks of major railroads. Operations over a branch rail line in Nevada would be similar to those on a mainline railroad, except the frequency of train travel would be much lower. Shipments in Nevada that used heavy-haul trucks would use Nevada highways in much the same way that other overdimensional, overweight trucks use the highways along with other commercial vehicle traffic.

Some State- and county-specific assumptions were used to analyze human health and safety impacts in Nevada. A major difference would be that much of the travel in the State would be in rural areas where population densities are much lower than those of many other states. Another difference would be for travel in an urban area in the state. The most populous urban area in Nevada is the Las Vegas metropolitan area, which is also a major resort area with a high percentage of nonresidents. The analysis also addressed the channeling of shipments from the commercial and DOE sites into the transportation arteries in the southern part of the State. Finally, the analysis addressed the commuter and commercial travel that would occur on highways in the southern part of the State as a consequence of the construction, operation and monitoring, and closure of the proposed repository.

This section presents information specific to Nevada that DOE used to estimate impacts for transportation activities that would take place in the State. It includes results for cumulative impacts that would occur in Nevada for transportation associated with Inventory Modules 1 and 2.